# *Advanced Transmission Technologies*

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Member of the **Hydro-Québec** group

# The State of Technology in Various Industries

| | Then | Now |
|---|---|---|
| Automobiles |  1932 Ford Sedan |  2005 Ford Escape Hybrid |
| Computing Devices |  Comptometer |  iMac G5 |
| Electric Transmission |  | ? Is it the same? |

# Commercially Available Advanced Transmission Technologies (1)

VSC-HVDC, STATCOM, SVC, FACTS

D-VAR, D-SMES

Composite Core Conductors

XLPE Cables

*(1) U.S. DOE National Transmission Grid Study – May, 2002*

# Advanced Transmission Technologies Increase Reliability

- Higher controllability over grid helps prevent cascading events
  - Prevents voltage / reactive power collapse
  - Prevents equipment overloads
- Undergrounding eliminates major causes of outages
  - Hurricanes, ice storms, tree contacts, lightning, fires
- Several studies confirm reliability of underground transmission
  - NC Utilities Commission (Nov. 2003) found that u/g outage rates are 50% less than overhead
  - MD Public Service Commission (Feb. 2000) found that u/g systems of urban utilities have lower frequency & duration of outages
  - Australian government (Nov. 1998) found that high voltage u/g systems had 80% less outages than overhead

# Underground Transmission Technology Is Proven, Fully Operable and Integrated with Grid

- Europe: Almost 5500 km (3400 miles) of high voltage HVDC and HVAC > 110 kV underground transmission -- all integrated into grid (1)
  - % of all transmission >220 kV (by length) that is underground: Denmark 16%; United Kingdom 6%
  - 25% of new < 400 kV transmission in France is required to be underground
- Traditional and advanced underground HVDC transmission technologies provide high availability with manufacturer warranties, availability guarantees, liquidated damages, etc.
- Advanced underground HVDC technology implemented in Sweden (Gotland 1999), Australia (2000 Directlink multi-terminal and 2002 Murraylink) and US (2002 Cross Sound Cable)

*(1) Commission of the European Community Background Paper – Undergrounding of Electricity Lines in Europe, December 10, 2003*

# Advanced Underground HVDC Transmission Technology: Low Impacts, Affordable

- Virtually no visual impacts
- Installation techniques are very simple
  - Installation similar to underground fiber optic cable
- No Electric Fields or AC EMF issues
  - HVDC and HVAC underground cables have no electric fields
  - Advanced underground HVDC cables - DC magnetic fields directly over cable are within natural variations of the earth's DC magnetic field
- Efficient use of existing rights-of-way (roads, pipelines, railroads, etc.)
- O&M cost of advanced underground HVDC less than overhead HVAC
- Advanced underground HVDC cost comparable to underground HVAC
- Advanced underground HVDC costs are declining, overhead HVAC costs are increasing

# Murraylink – World's Longest Underground Transmission Link


- In operation since October 2002
- 220 MW HVDC system based on VSC
- Distance 110 miles – all underground
- Average ROW width 13 feet (min 10 feet)
- Converter station sites ~ 3.5 acres each
- Permitting ~ 24 months
- Construction ~ 21 months
- 1 cable failure, found and repaired in 6 days
- 392 cable joints - no failures
- Availability + 98%
- Cost (includes 132 kV and 220 kV interconnections) ~ US$ 97M
- Annual O & M cost ~ US$1.5M/year

# Murraylink – Environmental Awards


- Australian Case EARTH Award
  - 2002 Environmental Excellence Award
- The Institution of Engineers, South Australia Division; 2003 Engineering Excellence Awards
  - Project infrastructure category
  - Overall project winner
  - Environmental category
- Royal Australian Planning Institute of South Australia; Environmental Planning and Conservation Award
- LandCare Australia; National Recognition for Re-vegetation Along Cable Route

# The State of Technology in Various Industries

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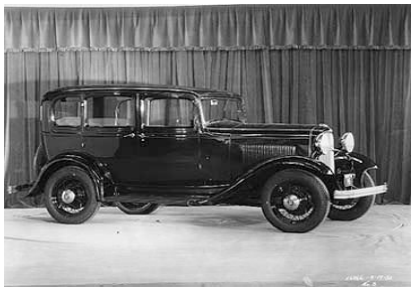
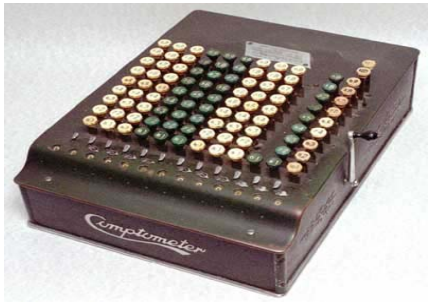
| Automobiles |  1932 Ford Sedan |  2005 Ford Escape Hybrid |
| Computing Devices |   Comptometer |  iMac G5 |
| Electric Transmission |  |  |

# For More Information……

- Our web sites:
  - General *www.transenergieus.com*
  - CSC *www.crosssoundcable.com*
  - Australia *www.transenergie.com.au*

- Contact information:
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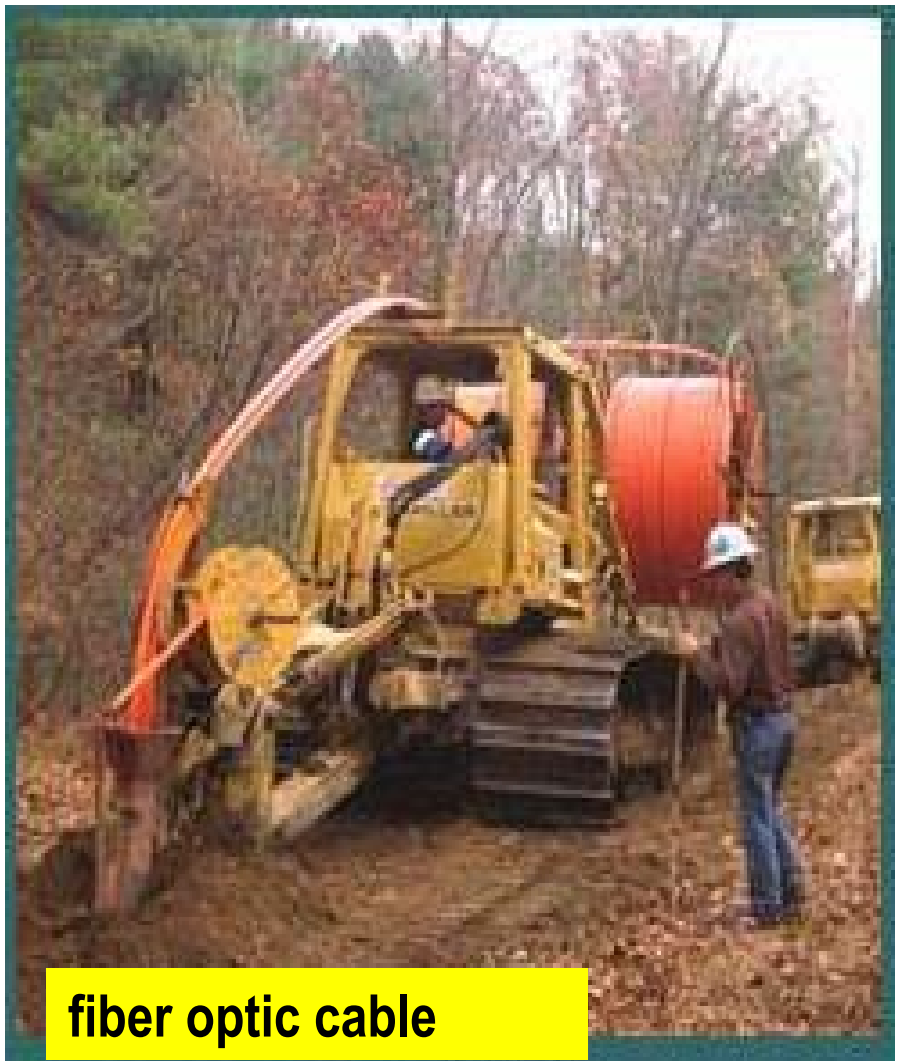
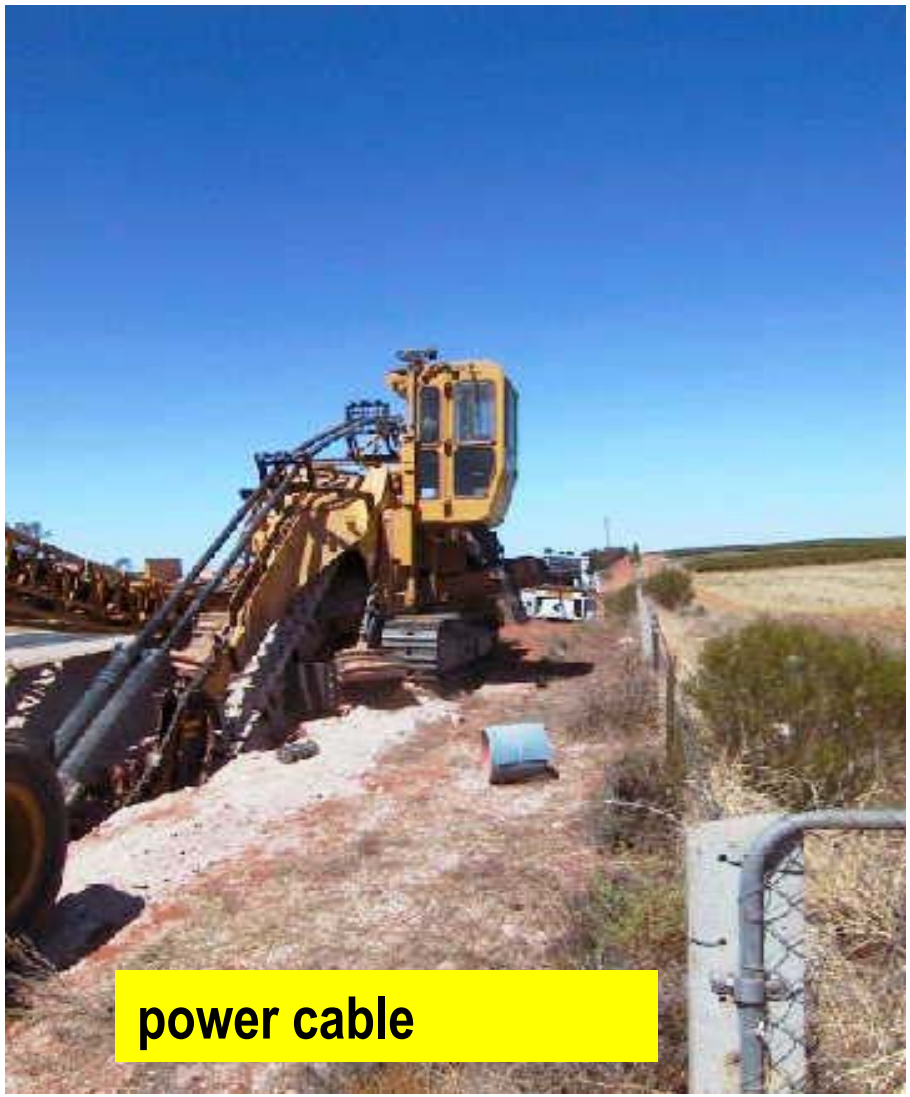
  - Ray Coxe (508) 870-9900 *ray.coxe@transenergieus.com*
  - José Rotger (508) 870-9900 *jose.rotger@transenergieus.com*

# BACKUP SLIDES

# Cable Installation Comparison



# Cable Installation Gotland - Rock Cutting

# Ploughing of the HVDC Light Cable - Gotland

# Murraylink Cable Installation

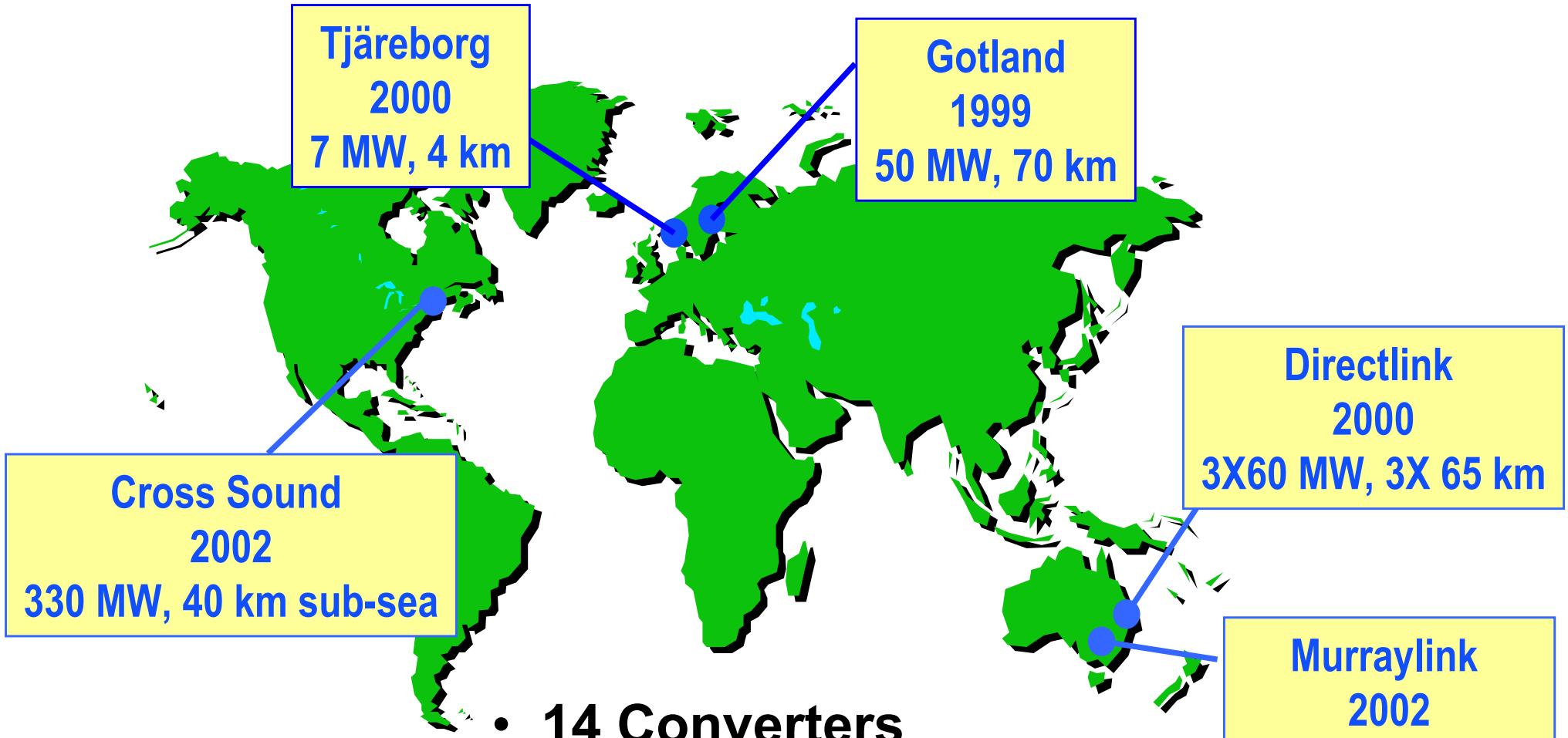

# Murraylink – Temporary Housing for Cable Splicing

# Murraylink – Land Cable Trenching

# Murraylink – Open Cut Cable Trench

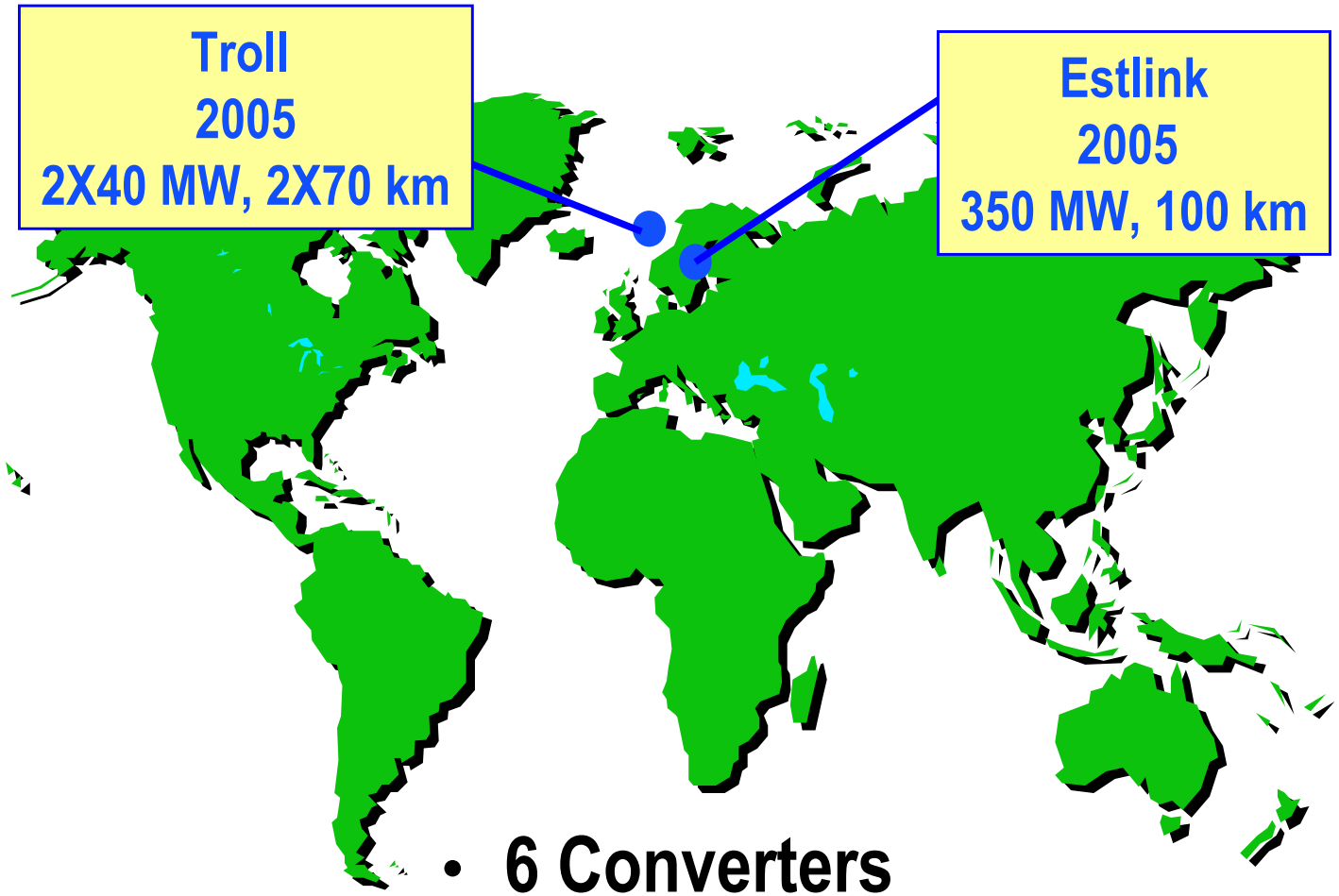
# HVDC Light - Bridge Conduit / Cable Crossing

# Existing Underground/Sub-sea HVDC Light Projects




- **14 Converters**
- **790 MW**
- **Sub-sea 40 km**
- **Underground 450 km**

# Planned Underground/Sub-sea HVDC Light Projects




- 6 Converters
- 430 MW
- Underground 100 km
- Sub-sea 290 km

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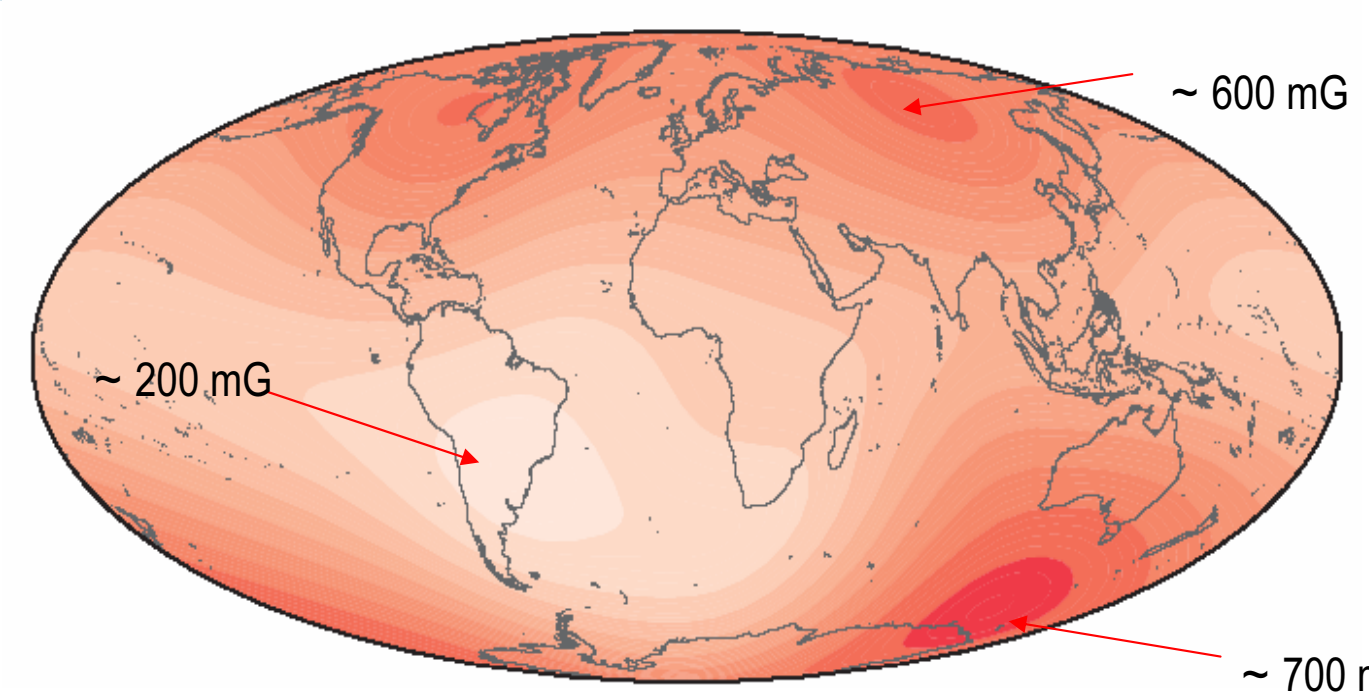
# DC Magnetic Fields




- The earth's natural DC magnetic field total intensity varies around the earth from approximately 200 mG to 700 mG
- Murraylink's maximum DC field intensity at 3 feet above the ground directly over the cable is 80 mG
- At distances from the cable greater than 10 feet, the change in the earth's natural magnetic field is extremely small